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La Quemada: Decline and abandonment in two stages on the classic period northern frontier of Mesoamerica

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ABSTRACT

An integrated magnetic survey was carried out on key places within the *La Quemada* archaeological complex, built over a hill on the northern frontier of Classic period Mesoamerica. Samples were collected from the *Plaza of Sacrifices* and *Hall of Columns* in an attempt to precisely determine the age intervals corresponding to the decline and abandonment of the site, apparently due to the intentional firing as a closure ritual. Well-defined characteristic remanent magnetizations were retrieved from 23 of 32 samples. Moreover, twelve samples belonging to two areas yielded reliable determinations under criteria curtailed in this study. In any case, a primary remanent magnetization is carried by pseudo-single-domain Ti-poor titanomagnetite, as evidenced by hysteresis and continuous thermomagnetic curves. The archaeomagnetic dating was performed using full geomagnetic vector (directions and absolute intensity) using the last SHADIF14k model. The *Plaza of Sacrifices* seems to been burned between a time interval from 854 to 968 CE, while a late interval from 1018 to 1163 CE is assigned to the samples collected in the *Hall of Columns*, which suggest the gradual abandonment of the site. The first abandonment stage is almost synchronous to the same phenomena observed for other sites at the *Bajío* area (central and western Mesoamerica) region. Under these circumstances, it cannot be discarded that *La Quemada* was burned in its entirety during the first stage of abandonment, but the Hall of Columns was again burned later.

1. Introduction

La Quemada archaeological zone is located in the central part of the State of Zacatecas (Mexico), within the municipality of Villanueva (Fig. 1). This place corresponds to the Malpaso Valley, where the Malpaso River runs south to join the Juchipila-another known with the name of La Quemada. This valley is delimited by the Sierra Palomas towards the east and the Sierra de Morones to the east; fertile lands exist in the middle irrigated by the river and several streams. The old settlement was established in a topographic elevation taking advantage of the land to build spacious edifices using large terraces.

La Quemada (Fig. 1) is one of the larger settlements in northern Mesoamerica. Describes it as a “ceremonial center made up of artificial terraces, platforms, staircases, causeways, ball courts, sunken patios, temples, and residential complexes, most of which are enclosed within a series of imposing cliffs and massive masonry walls”. The functions and relationships of La Quemada have been highly controversial and speculative. Through the twentieth century, this monumental ruin was correlated even with the legendary Chicomóztoc, through which the Mexicas passed on their pilgrimage on the journey to *Anahuac*. Archaeologists have seen it as a Teotihuacan enclave, a Toltec empire or even a Tarascan bastion against Chichimec intrusions (Jimenez Betts, 1994, 2005; Jimenez Betts and Darling, 2000).

When the construction of the hacienda and neighboring towns began around the ruins of La Quemada (beginning of 18th century), this monumental site was used to extract stone. The evidence of dark spots on walls and floors, as well as charred wood was first observed during this time. This led to the speculation that a great fire consumed the ancient city. At present, it is considered that the city was intentionally burned as a part of a closure-ceremony ritual. However, no chronological constraints support this hypothesis. Despite the many high-quality radiometric ages available from the site, still, no absolute date is assigned to the supposed Big Fire. In the present investigation, we attempted to archaeomagnetically date the most important and apparently well-burned areas in different constructive stages of La Quemada. The analysis consisted of: a) alternating field demagnetization, b)

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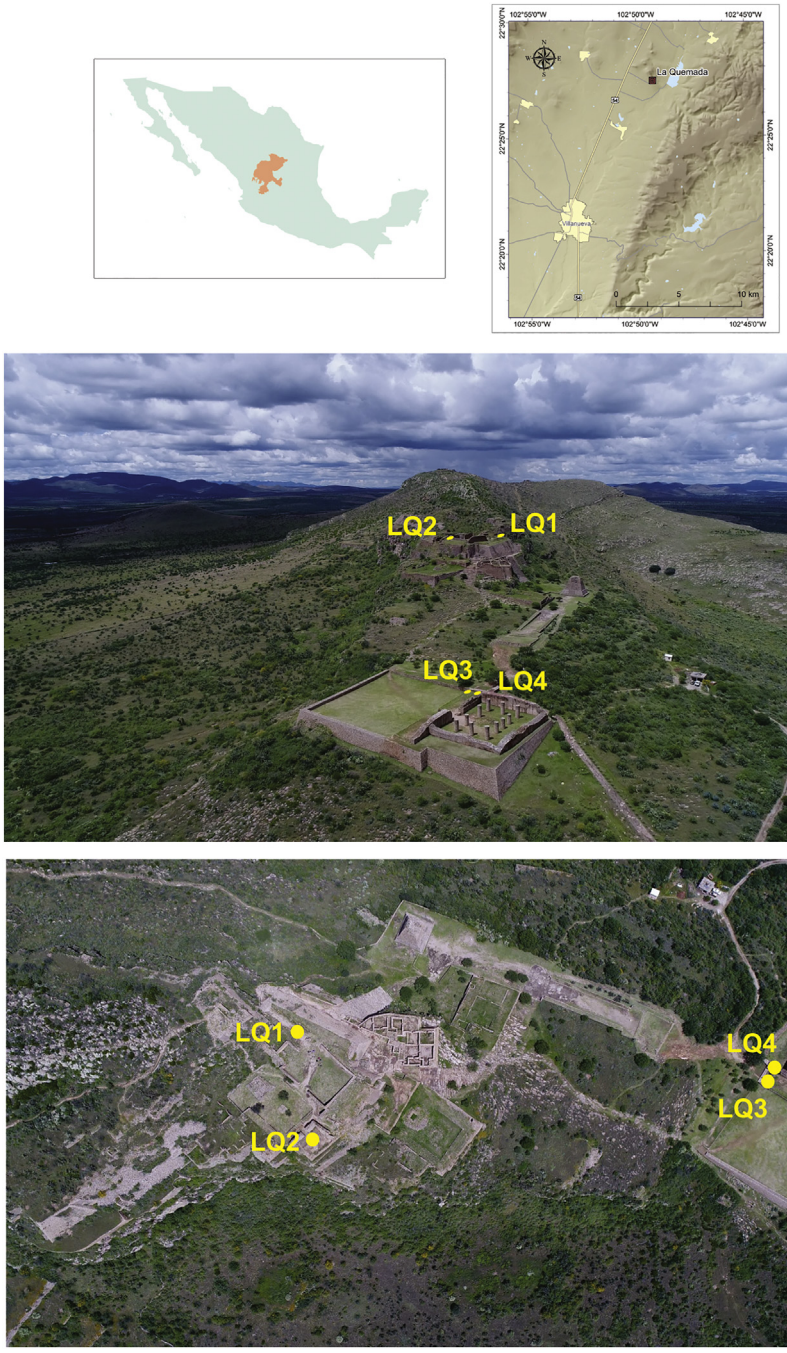

Fig. 1. Schematic locations map and general view of La Quemada archaeological complex in State of Zacatecas, Mexico showing sampled sites.

hysteresis and thermomagnetic experiments and c) absolute intensity determination.

2. Archaeological context and sample provenance

The initial phase of occupation in the Valley of Malpaso and La Quemada seems to have occurred between 400 and 600/650 CE due to the similarity in the decoration of the Canutillo pottery of the Chalchihuites Culture, for which a common origin denominated the *Canutillo-Malpaso* horizon (Jimenez Betts, 2005; Jimenez Betts and Darling, 2000). Within this area, La Quemada is the most documented and researched site of all the settlements in the Malpaso valley, pointing to the main age interval from 600/650 to 850 CE based on available radiometric dates (Nelson, 1997). There are new ceramic types that indicate a cultural change in the region during the Epiclassic period (600–900 CE), highlighted by ceramics elaborate negative painted decoration and figurative designs defined as the Tepozán type (Jimenez Betts and Darling, 2000). Other ceramics share styles with those found northwest of La Quemada, Los Altos de Jalisco, and the Bajío regions. Likewise, intrusive polychrome ceramics (Valle San Luis) correspond to the Tunal Grande region, southeast of Zacatecas from northeastern Guanajuato and western San Luis Potosí (Jimenez Betts and Darling, 2000).

As for the settlement itself, there is ample evidence of massive constructions within the large sections of the monument that is still visible today. The architecture recalls the Mesoamerican tradition with truncated pyramidal monuments, square patios with central altars and well-developed housing areas around the larger settlement. The Hall of

Columns represents (Fig. 1) a regional architectural feature, which will later be found throughout the center and southern Mesoamerica. In the valley, there are several settlements scattered around La Quemada communicated by a network of a prehispanic road-system (Trombold, 1985). These sites had different functions, among them, to facilitate the transport of natural resources such as clay banks, wood or agricultural fields, craft workshops, sacred spaces, and possible secondary administrative sites. It has also been pointed out the possible existence of a ritual landscape where ceremonies were dedicated to the sun (Medina-González, 2000). The final 'La Ciudadela' phase is placed between 850 and 1000 CE and seems to correspond to a *crisis stage* in the valley, which caused an abandonment of the site having been burned (Jimenez Betts and Darling, 2000; Jiménez Betts, 2010).

First chronological estimations of La Quemada come from the excavations of Pedro Armillas undertaken in 1951 in *El Cuartel*, obtaining dates ranging between 775 and 1200 CE. Subsequent excavations by Armillas a decade later in El Cuartel produced 10 carbon samples for radiometric analysis, which provided dates that range from 1080 to 1540 CE. Based on this information, La Quemada was considered to correspond to the Postclassic period (900 to 1100 CE), founded as an intermediate point of the turquoise route that linked Chaco Canyon in the North American Southwest with Tula in central Mexico. It was not until the decades of the 80s and 90s when radiometric studies are retaken to determine the absolute chronology of the Malpaso Valley. In the case of La Quemada, Trombold (1985) obtained the first technically high-quality radiometric ages. Ben Nelson (1997) dated 39 samples, 19 from a Terrace and 20 from midden deposits within the area of the 56 terraces. Nelson argues that La Quemada was founded around 500 CE, with its peak development between 600 and 750 CE, and beginning its decline in 800 CE, and final abandonment in 900 CE. (Nelson, 1997).

The samples from this study belong to the Hall of Columns and the Plaza of the Sacrifices. The Hall of Columns (Fig. 1), one of the main buildings of the settlement due to its architectural peculiarity, is located at the southern end of the lower level of La Quemada (Figs. 1 and 2). The interior measurements of the building are 30 × 40 m, with masonry perimeter walls and columns that reach 6 m in height. The door on the west face of the building is highlighted two columns, which supported a lintel or enclosure to support the roof at the entrance. Excavations undertaken within the Hall of Columns found the building to have been totally roofed, and during its use refloored on 4 occasions (Jiménez Betts, 2010). Radiocarbon samples taken from three charred roof beam fragments found directly over the brick-red colored baked clay floor, produced from the smoldering collapsed roof, date to 870–990 CE (1 sigma calibrations all dates), 680–800 CE, and 670–780 CE (Jimenez Betts and Darling, 2000), marking the construction of this structure. In the present study, two samples (LQ3 and LQ4) come from the northern sector of the Hall of Columns (Fig. 2). The first one corresponds to a floor of hardened clay, which was exposed to the fire that apparently destroyed the city during its abandonment (LQ3). The second sample corresponds to a fragment of the flattened wall (LQ4) of the facade of the Hall of Columns at its northern end. The Plaza of Sacrifices is part of the third level of the settlement, that is, at the top of the hill. It consists of a large square with an altar to the center delimited by sidewalks and rooms to the east, south, and west, while to the north there is a pyramidal basement of four bodies. Both oriented samples from this area (LQ1 and LQ2) were obtained from the burned floors.

3. Laboratory techniques

Several rock-magnetic and archaeomagnetic experiments were carried out in order to determine the characteristic remanent magnetization directions, reveal the origin of the main magnetic carriers and select the most promising samples for archaeointensity measurements. These experiments consisted of systematic alternating field demagnetization of 32 specimens belonging to four sites, the measurement of saturation magnetization versus temperature (also known as continuous thermomagnetic curves) plots, hysteresis cycles and the acquisition of isothermal remanent magnetization curves using a Variable Field Translation Balance. Continuous thermomagnetic curves were obtained heating the samples in the air up to 600 °C and cooling them down to room temperature. Remanence measurements were carried out using both AGICO JR5 and JR6 spinner magnetometers while alternating field treatments were performed using a LDA-5 demagnetizer. Absolute intensity experiments were carried out using the Thellier-type double heating method (Thellier and Thellier, 1959) as modified by Coe et al. (1978). An MMTM-80 paleointensity oven was used for these experiments. The measurements were carried out in 13 temperature steps (Fig. 5) between room temperature and 560 °C. After the third heating step, control heatings (so-called pTRM-checks) were performed

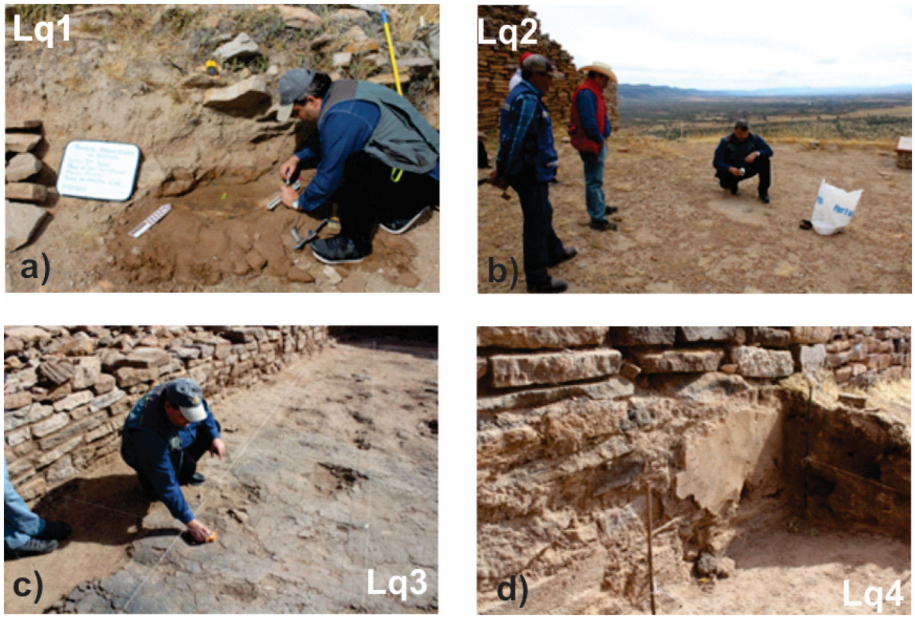

Fig. 2. The details of sampled locations: LQ1 and LQ2 sites belong to the Plaza of Sacrifices while LQ3 and LQ4 correspond to the Hall of Columns. See text for more details.

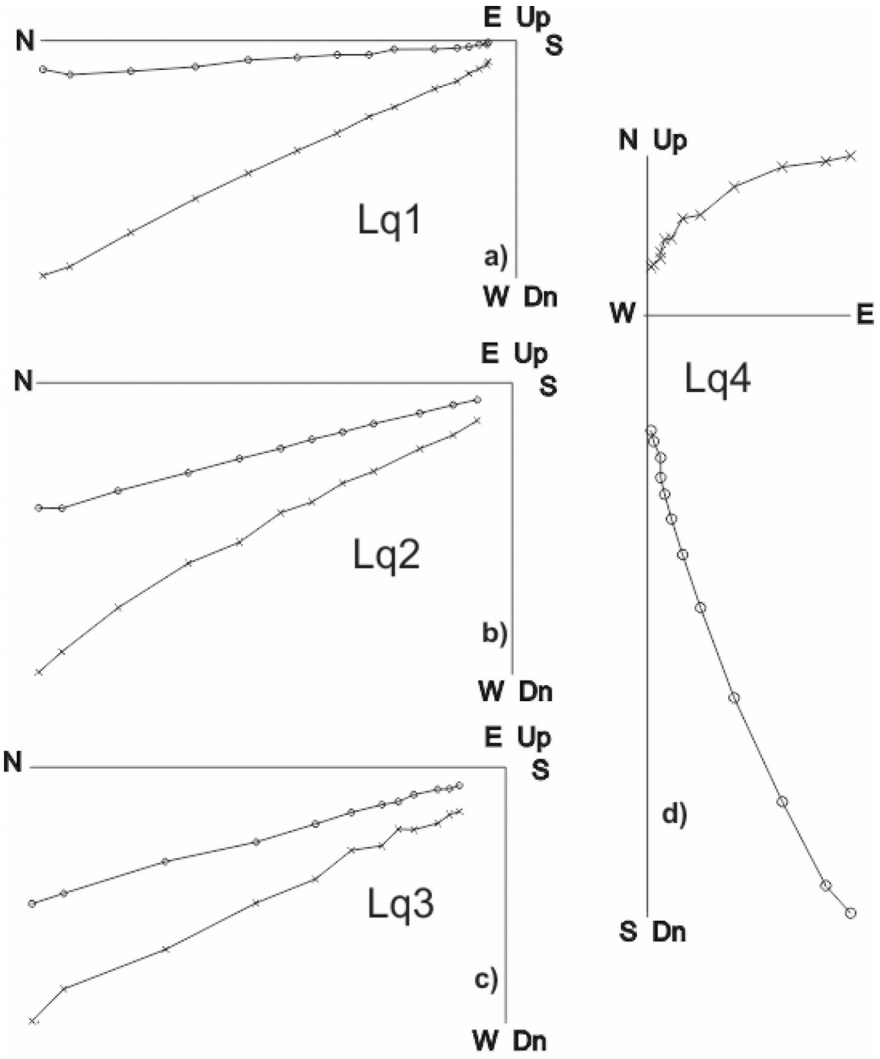

Fig. 3. Representative examples of orthogonal vector plots (also known as Zijderveld diagrams) illustrating the alternative field treatments up to 95 mT for La Quemada samples.

throughout whole experiments. The cooling rate dependence of TRM (Thermoremanent Magnetization) was investigated following a modified procedure to that described by Chauvin et al. (2000), while remanence anisotropy effect was mitigated following the procedure reported by Morales et al. (2015). During the archaeointensity experiments, hand samples under study were fragmented into 6 specimens and pressed into salt pellets to manipulate them as standard paleomagnetic samples.

4. Main results and concluding remarks

Reliable paleomagnetic directions were obtained from 23 of 32 samples. The evidence of single and magnetically stable component is revealed for all samples belonging to sites LQ1, LQ2, and LQ3 (Fig. 3a and b). No single determination was obtained from site LQ4 (8 samples) since alternating field treatments were unable to separate the primary magnetization component (Fig. 3c). These observed, apparently multiple magnetic overprints may be due to the lightning effect of local character. No primary, characteristic remanence was isolated after applying maximum available alternating field of 95 mT. The occurrence of hematite is not attested on a continuous thermomagnetic curve which clearly indicate the presence of Ti-poor titanomagnetite (very close to ferrimagnetic magnetite phase). The isothermal remanence (IRM) acquisition curve also discards the possible presence of antiferromagnetic hematite since the saturation is reached at low to moderately applied fields. All samples belonging to site LQ4 were discarded for further paleointensity measurements.

Twelve samples belonging to LQ1 and LQ3 sites yielded reliable determinations under the following acceptance criteria: (1) Number of points on NRM decay/TRM gained diagrams exceeds 6. (2) The initial remanence fraction *f* (Coe et al., 1978) more than half. (3). The quality factor $q \geq 5$. (4) No concave up behavior is observed on the NRM-TRM plots. (5) No evidence of the remanent magnetization deviations towards the direction of laboratory field and (6) positive pTRM checks (within the 15% percent at the initial stage (until 400 °C) and 10% between 400 and 560 °C). Statistically, undisguisable paleodirections were obtained from sites LQ1 and LQ2 (Fig. 4). Thus, the mean directions were calculated using all samples belonging to LQ1 and LQ2 yielding Inc = 33,67°, Dec = 356,16°, a95 = 2.1°, and k = 323. Site LQ3, based on 8 demagnetizations, yielded following mean paleodirections: Inc = 40,59°, Dec = 345,55°, a95 = 3,4° and k = 266. As archaeointensity determinations are concerned (Table 1 and Fig. 5), we consider them as reliable since associated thermomagnetic curve (Fig. 5) show reasonably reversible behavior pointing to Ti-poor titanomagnetite as the main magnetic carrier, while hysteresis plot and isothermal remanent magnetization curves attest the probable presence of small pseudo-single-domain ferrimagnetic minerals. Site LQ1 (square of sacrifices) provided in average an intensity of 40.6 ± 2.6 μT, while

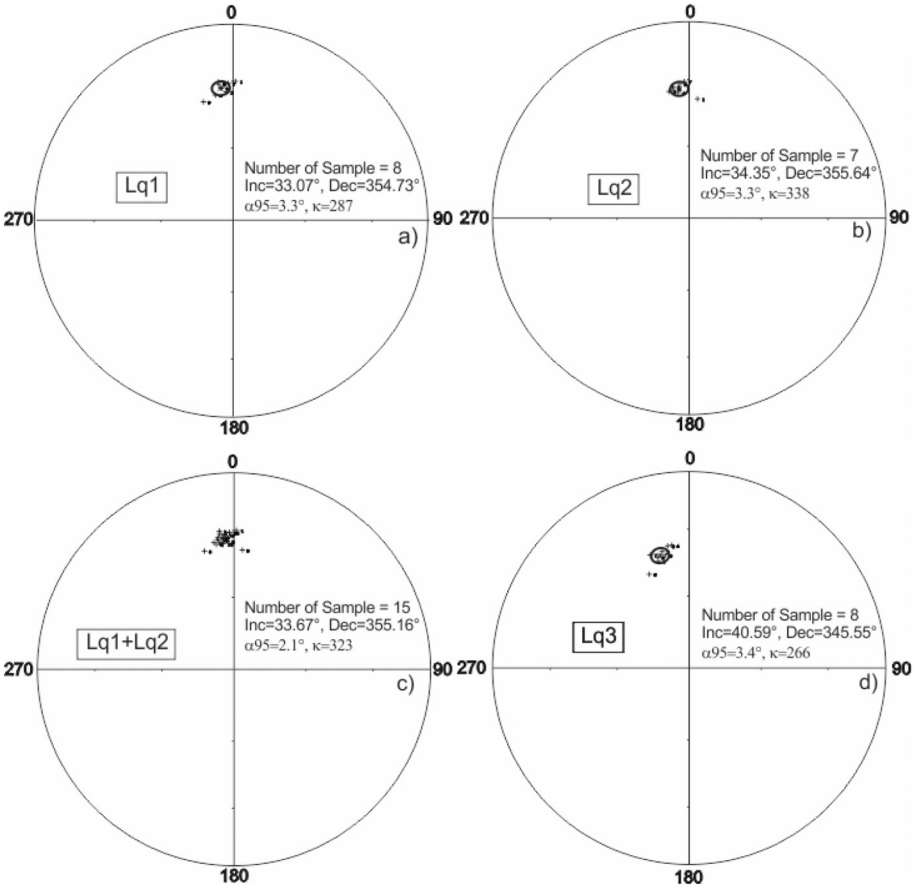

Fig. 4. Stereographic projection of site mean paleodirections together with the parameters of Fisher statistics. No paleodirections were obtained from site LQ4 (see text for more details).

Table 1
Archaeointensity results at sample level, N: the number of heating steps used; *f*, the fraction of NRM used for intensity determination; *g*: the gap factor; *q*: the quality factor as defined by Coe et al. (1978); H_{corr}: archeointensity value corrected for cooling rate effect.

Sample	Lab code	N	Han (μT)	± μT	f	g	q
LQ1							
LQ1-3A	08Q014A-1	9	42.6	2.4	0.53	0.87	5.8
LQ1-3B	08Q014A-2	7	35.8	2.1	0.49	0.85	9.3
LQ1-3C	08Q014A-3	8	38.4	1.9	0.63	0.79	11.2
LQ1-2A	08Q014A-4	8	43.3	3.3	0.54	0.78	4.8
LQ1-2B	08Q014A-5	8	47.2	3.2	0.61	0.84	6.2
LQ1-2C	08Q014A-6	7	36.4	2.7	0.58	0.82	5.2
LQ3							
LQ3-1A	08Q032A-2	14	50.8	4.2	0.61	0.80	5.6
LQ3-1A	08Q032A-3	14	66.2	5.9	0.62	0.83	7.2
LQ3-1A	08Q032A-4	14	55.3	6.1	0.58	0.77	6.8
LQ3-1A	08Q032A-5	14	65.3	7.2	0.53	0.79	9.1
LQ3-1A	08Q032A-6	14	49.2	5.2	0.47	0.85	7.0
LQ3-1A	08Q032A-7	14	52.3	4.7	0.55	0.81	5.1

LQ3 (Hall of Columns) yielded 56.5 ± 3.9 μT. Generally speaking, an archaeointensity determination is much more delicate and time-consuming than directions because only samples with some specific criteria may be selected (i.e. evidence of single and stable remanence component and reasonably reversible thermomagnetic curves) for such purpose. Thus, site LQ4 was discarded at the initial stage of experiments and site LQ2 provided low technical quality determinations (number of points on NRM decay/TRM gained diagrams were systematically < 5. The initial remanence fraction *f* (Coe et al., 1978) < 30% and the quality factor *q* < 5. In addition, some of the control heatings (so-called pTRM checks) were negative.

The archaeomagnetic dating (Figs. 6 and 7) using the last SHA-DIF14k model of Pavón-Carrasco et al. (2011, 2014) gives a time interval between 854 and 968 CE (Fig. 6) as the most probable age estimate for the uppermost sites (LQ1 and LQ2 Square of Sacrifice). It should be noted that the time interval between 722 and 820 CE cannot be completely discarded. The Hall of Columns (LQ3), considered the main ritual space in the site, yielded a time interval between 1018 and 1163 CE, which do not match with the main core of available, high-technical quality radiometric age estimations for La Quemada. These results may indicate that La Quemada was burned on two occasions or in two stages. Likewise, we cannot exclude the possibility that the general fire occurred in a number of sections of the site between 854 and 968, but the Hall of Columns was re-burned between 1018 and 1163 CE.

An important issue in understanding La Quemada resides in a better knowledge of the chronology of the site's occupation. It has generally been proposed that sometime around 300–350 CE a migration of simple village-level sedentary populations from the Bajío area (southern Guanajuato, northeastern Jalisco) appear to have arrived in the valleys of central and northern Zacatecas where they coexisted, and partially transformed, some of the seminomadic groups, in a process modeled as soft diffusion (Kelley, 1974; Jimenez Betts, 2005). This resulted in the early phase of sedentary occupation of the Malpaso valley. At present, there is a consensus among researchers that early site occupation began sometime between 400 and 500 CE, a period known as Malpaso Complex (Jimenez Betts and Darling, 2000, Jimenez Betts, 2005; Nelson, 1997). Early ceramic types show a strong similarity in black tripod vessels with geometric incised patterns to those of the Chalchihuites culture zone (Jimenez Betts, 1989; Trombold, 1985). The next phase,

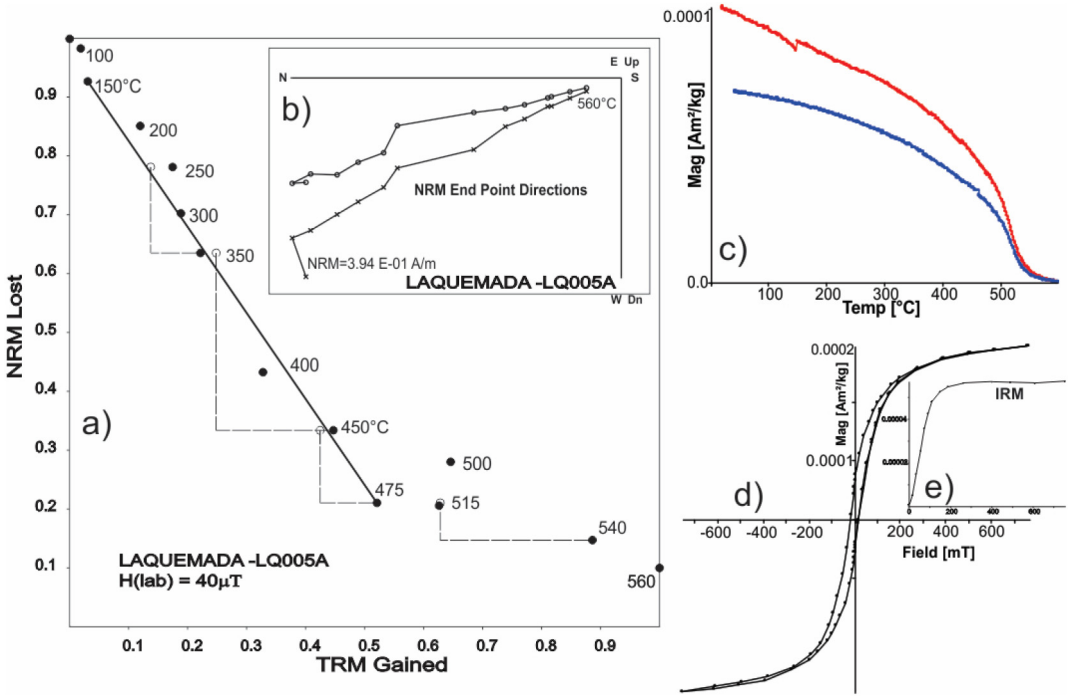

Fig. 5. Representative Natural Remanent Magnetization (NRM) – Thermomagnetic Remanent Magnetization (TRM) plots (so-called Arai-Nagata plots) and associated orthogonal vector, NRM end points demagnetization diagrams for the representative samples. Also shown is hysteresis cycle, isothermal remanence acquisition and continuous thermomagnetic curve recorded on the sister sample.

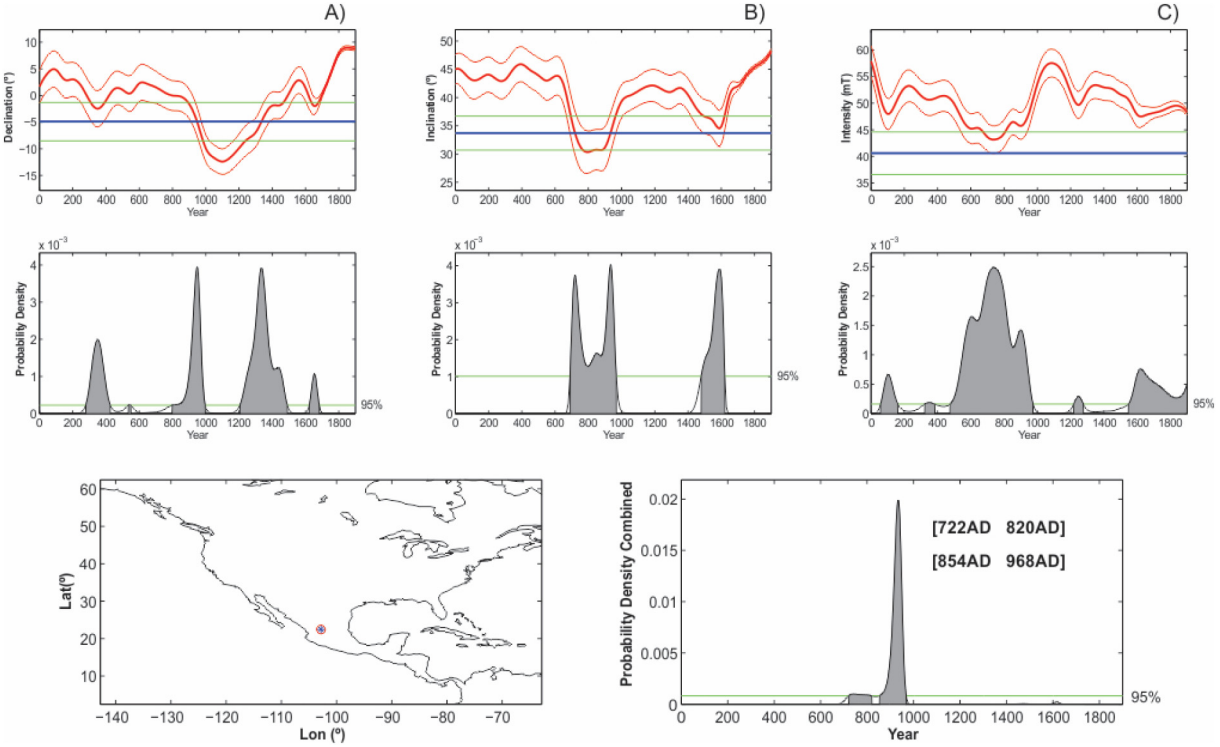

Fig. 6. Archaeomagnetic dating using a MATLAB tool provided by Pavón-Carrasco et al. (2011, 2014) for the Square of Sacrifices samples based on full paleomagnetic vector variation: a) Declination, b) Inclination and c) Absolute Intensity.

the 'La Quemada complex' from 600/650 and 850 CE represents the Mesoamerican Epiclassic period occupation in the site and valley and constitutes the La Quemada's apogee (Jimenez Betts, 1989; Jimenez Betts and Darling, 2000; Nelson, 1997; Trombold, 1985). Regarding the final occupation of La Quemada, there is no consensus as of yet, although a final phase, 'the Ciudadela', between 850 and 1000 CE has been proposed from Lelgemann's work in the northernmost sector of La Quemada (Jimenez Betts and Darling, 2000).

It is currently considered that La Quemada was intentionally burned, in a ritual manner as part of some form of closing ceremonial event. Traditionally, it has also been proposed that the end of the Epiclassic period was characterized by migratory movements and

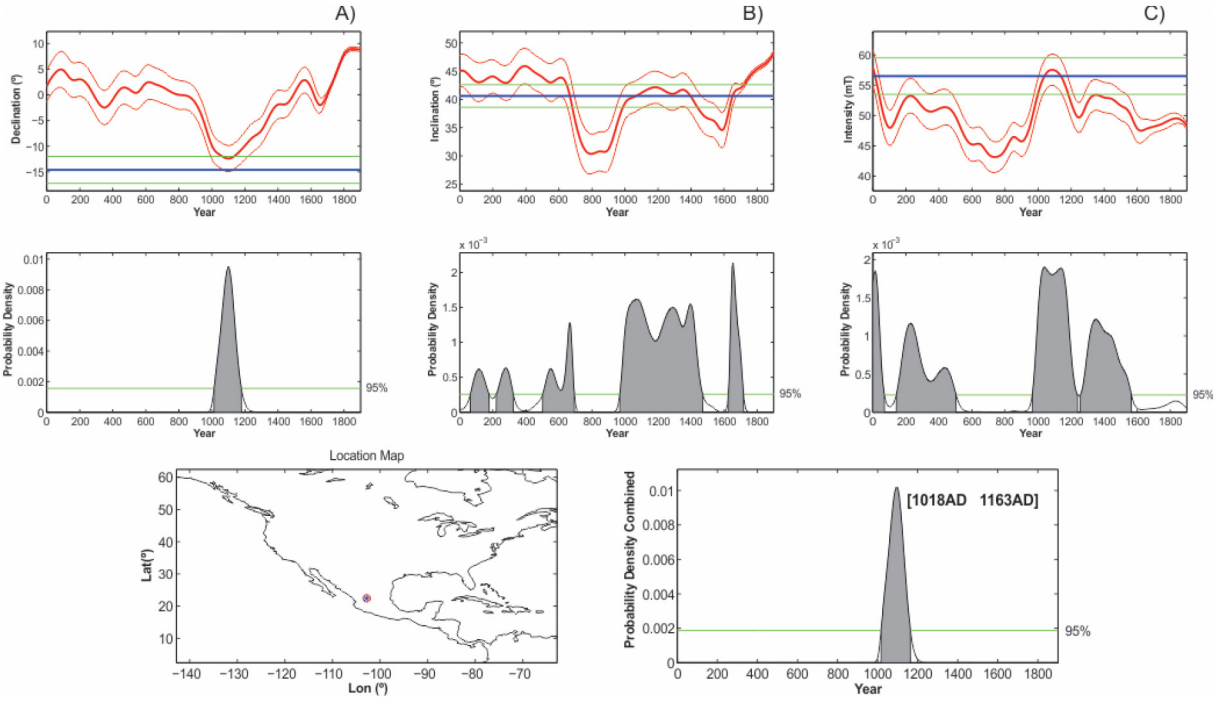

Fig. 7. Archaeomagnetic dating using a MATLAB tool provided by Pavón-Carrasco et al. (2011, 2014) for the Hall of Columns samples based on full paleomagnetic vector variation: a) Declination, b) Inclination and c) Absolute Intensity.

abandonment of the main settlements of the northern border of Mesoamerica (Davis, 1977; Jimenez Moreno, 1966; Hers, 1989; López-Austin and López-Luján, 1999), thought to have been brought on by climate change at around 1100 CE (Armillas, 1964, 1969). This hypothesis has only recently been subject to close scrutiny. Paleoclimate reconstructions undertaken during the last 20 years have shown the present day semi-desert environment of the region to have been produced at the end of the 17th and early 18th centuries, in all likelihood, stemming from intensive deforestation to secure wood and carbon-coal for colonial mining activities in and around Zacatecas (Elliot et al., 2010; Somerville, 2015), while the prehispanic climate was stable for agriculture and presented little evidence of significant change. This has underscored the probability that the collapse of La Quemada, and much of the northern frontier, may have fallen as a result of sociopolitical reasons, rather than climatic change and nomadic invasions for which evidence is scarce.

A recent pan-regional study suggests La Quemada collapsed between 1000 and 1050 CE as a result of interaction network change that affected the prestige goods network that linked La Quemada to central Jalisco during the Epiclassic period. This network was interrupted by the appearance of a new network system extending across the lake basins of West Mexico that bound Tula with the Aztatlan zone of the Pacific coast at 1000–1050 CE, severing the Epiclassic network system resulting in the decline and fall of La Quemada, together a number of the neighboring culture spheres of the Epiclassic northern frontier (Jimenez Betts, 2018). Patterns indicative of destructive fires related to site collapse have been verified in places such as Plazuelas, in the Guanajuato area, where evidence was found that the temples, palaces, emblems, and gods were destroyed and the city burned, being completely abandoned in 900–1000 CE (Castañeda-López and Quiroz-Rosales, 2004; Morales et al., 2015). Moreover, there is also looting of offerings and mutilation of sculptures in order to desacralize the space (Castañeda-López and Quiroz-Rosales, 2004). In the site of Barajas, near Plazuelas, a similar phenomenon is observed, where the data recovered in the excavations indicate that in the *Yacata del Ángel* the doors were carefully boarded-up; prior to this action, large sherds were placed of a crude red pot, which refers to a closing ritual (Migeon, 2003). At the El Cerrito site in Queretaro, charred wood remains were detected from columns and roof beams (Valencia-Cruz, 2015). Sites in the Tunal Grande region also suffered extensive fires at the time of their abandonment (Torreblanca-Padilla, 2015).

Settlements within the present day state of Zacatecas have produced contexts that could be seen as evidence of ritual closure, or in one case, of possible violence. In the case of the site of Alta Vista, in northeastern Zacatecas, Kelley proposes a context of warfare, involving human sacrifice, having completely destroyed this ceremonial center, which was burned and abandoned (Kelley, 1990). Likewise, the analysis of the same contexts can be seen as having originally constituted bundled burials suspended from perimeter beams that fell onto the plaza floors from a ritual closure fire. For the Malpaso Valley, recent excavation in the entrance of the Hall of Columns of La Quemada detected numerous elaborate Tepozán negative painted vessels, placed on the floor as an apparent ritual offering of closure prior to the fire of the Hall. Inside the Hall, a large amount of human-bone remains were detected beneath collapsed roof as a result of the intense fire (Jiménez Betts, 2010; Medina-González, 2012).

Up until now, little was known concerning the events of the last stage of occupation in La Quemada, however, new data permits a set of new questions to be formulated and researched. At present, we have evidence that suggests a gradual abandonment, in which closing rituals were performed, such as the placement of offerings and intentional fires. Based on the new dates, we argue that a gradual abandonment of the city, firstly in the part of the Acropolis (Plaza of the Sacrifices) where there is also evidence of the closing of the access stairs (Jiménez Betts, 2010). Subsequently, the lower part of the settlement, the Hall of Columns is burned, in what appears to be the final closing of this monumental site.

Acknowledgments

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